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**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

Applicants: Roger R. Lesieur et al

Serial No.: 10/042,056

Filed: January 10, 2002

For: "Method for Desulfurizing Gasoline or Diesel Fuel for Use in a Fuel Cell Power Plant"

Docket No.: C-2373 Cont.

Group: 1764

Examiner: N. Norton

COMBINED NOTICE OF APPEAL AND APPEAL BRIEF UNDER RULE 192

Commissioner for Patents
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Dear Sir:

This is an appeal from the decision of the Primary Examiner dated July 14, 2003 finally rejecting claims 1-11 and 20-25 in the above-identified application.

(1) REAL PARTIES IN INTEREST: The real party in interest in this case is UTC Fuel Cells of South Windsor, CT.

(2) RELATED APPEALS AND INTERFERENCES: There are no related appeals or interferences relating to this application.

(3) STATUS OF CLAIMS: All of the claims have been either canceled or finally rejected.

(4) STATUS OF AMENDMENTS: All amendments have been entered.

(5) SUMMARY OF THE INVENTION:

A fuel processing method is operable to remove substantially all of the sulfur present in an undiluted oxygenated hydrocarbon fuel stock supply which contains an oxygenate and which is used to power a fuel cell power plant in a mobile environment, such as an automobile, bus, truck, boat, or the like, or in a stationary environment. The power plant hydrogen fuel source can be gasoline, diesel fuel, or other like fuels which contain relatively high levels of organic sulfur compounds such as mercaptans, sulfides, disulfides, and the like. The undiluted hydrocarbon fuel supply is passed through a desulfurizer bed (8) wherein essentially all of the sulfur in the organic sulfur compounds reacts with the nickel reactant, and is converted to nickel sulfide, while the now desulfurized hydrocarbon fuel supply continues through the remainder of the fuel processing system. The method does not require the addition of steam or a hydrogen source to the fuel stream prior to the desulfurizing step. The method can be used to desulfurize either a liquid or a gaseous fuel

stream, which contains an oxygenate such as MTBE, ethanol, methanol, or the like. The inclusion of the oxygenate serves to extend the useful life of the desulfurization method. The method can operate at temperatures in the range of about 300°F to about 450°F thus enabling its use in a mobile environment as described above.

(6) ISSUES: Are any of Claims 1-8 and 20-25 rendered obvious solely by the teachings of Setzer et al? Are any of Claims 9-11 rendered obvious by the combined teachings of Setzer et al and Alexander et al?

(7) GROUPING OF CLAIMS:

Claims 1-8 stand or fall together. Claim 9 stands or falls by itself. Claim 10 stands or falls by itself. Claim 11 stands or falls by itself. Claims 20 and 21 stand or fall together. Claims 22-25 stand or fall together.

(8) THE ARGUMENT:

The References Relied Upon:

U.S. Pat. No. 3,485,746, Setzer et al, issued December 23, 1969; and
U.S. Pat. No. 6,103,103, Alexander et al, issued August 15, 2000.

A Brief Description Of The References:

The Setzer et al reference discloses a system for removing sulfur from hydrocarbons. The specific hydrocarbon described in the reference is JP-4 which has been doped with thiophene. JP-4 is a jet fuel. The total amount of sulfur in the doped fuel is 400 ppm. The sulfur-removing reactant is a finely ground (10-16 mesh) fifty percent nickel reactant supported on a mineral such as kieselguhr. The desulfurizer bed is deemed to be operating properly if the desulfurized fuel stream has less than 20 ppm. This is referred to as the breakthrough level of sulfur. Amounts greater than 20 ppm indicate that the reactant bed has been saturated with sulfur and is no longer performing properly. The sulfur removal operation is performed at temperatures in the range of 500°F-800°F. FIG. 2 of Setzer et al shows the breakthrough times in hours at various temperatures within the aforesaid operating range. This figure indicates that a preferred operating temperature would be about 600°F since that operating temperature provides the longest time period before breakthrough occurs.

The Alexander et al reference describes a process and apparatus for the dehydrogenation of paraffinic hydrocarbons which hydrocarbons contain oxygenates. specific oxygenates mentioned are MTBE, ETBE and TAME. The dehydrogenation procedure is performed by the use of a molecular sieve which has a platinum group metal and zinc catalyst on a support made of borosilicate and an alkali metal. Col. 2 of Alexander et al also describes a

number of prior art dehydrogenation procedures which utilize a hydrogen additive.

The Rejections:

Claims 1-8 and 20-25 have been finally rejected as being obvious over Setzer et al.

Claims 9-11 have been finally rejected as being obvious over Setzer et al and Alexander et al.

There are also a number of provisional double patenting rejections contained in the final rejection which will not be addressed in this appeal since they are provisional. These provisional double patenting rejections will be addressed if and when any of the claims in this application are indicated as being allowable.

The §103 Rejections:

Claims 1-8

Claims 1-8 of the instant application require that the effluent fuel stream exiting the desulfurization bed contain no more than about 0.05 ppm sulfur. The Examiner has focused on the use of the term "trace" in the Setzer et al patent, and has alleged that "It would have been obvious to one of ordinary skill in the art at the time the invention was made to desulfurize the Setzer et al +++ fuel to any degree required to produce a suitable fuel cell feed, including applicant's' less than 0.05 ppm sulfur +++". (emphasis added). In Setzer et al, it is clearly suggested that a "trace" amount of sulfur is less than 20 ppm. Thus, 19 ppm is a "trace" amount of sulfur as far as Setzer et al is concerned. The Examiner has suggested that one skilled in the art would be able to use the teachings of Setzer et al to achieve an effluent having less than 0.05 ppm sulfur, or in fact any "desired level" which is less than 20 ppm. Thus, following the Examiner's line of reasoning, one skilled in the art could use the teachings of Setzer et al to achieve an effluent having, say, 0.000001 ppm sulfur, since this amount is less than 20 ppm. While making this bold allegation, the Examiner has not pointed out which parameters in Setzer et al would have to be manipulated in order to achieve an effluent having less than 0.05 ppm sulfur. The Examiner is reminded that the rejection of Claims 1-8 is based solely on the contents of the Setzer et al reference, and on nothing else. In order to discharge her burden of proof, the Examiner should present a cogent analysis of the Setzer et al reference pointing out what parameters Setzer et al suggests should be varied by one skilled in the art to achieve the claimed less than 0.05 ppm sulfur content effluent. For example, would one increase (or decrease) the amount of water suggested by Setzer et al; or would one increase (or decrease) the operating temperatures of the desulfurizer? The Examiner must also point out where in the Setzer et al reference she finds these clues as to how to achieve the claimed less than 0.05 ppm sulfur levels.

On page 10 of a previous office action, the Examiner states that: "The reference's (Setzer et al) disclosure of 'amounts below those amounts detectable' suggests a low amount which may encompass applicants' 0.05 ppm." (emphasis added). For one thing, the use of the phrase "amounts below those amounts detectable" describes undetectable amounts of sulfur in the effluent stream prior to breakthrough, which occurs at 20 ppm. This indicates that amounts of sulfur below 20 ppm are amounts which are not detectable by the Setzer et al system. This indicates that the sulfur detector can only detect amounts of sulfur in the effluent which are greater than 20 ppm. This, in turn, indicates that the detector in Setzer et al would not be able to detect amounts of sulfur between 0.05 ppm and 20 ppm. Furthermore, the fact that a result which "may" be achievable, in the Examiner's opinion, does not render the achievement of such a "may be" result obvious. The mere fact that prior art may be modified does not make the modification obvious unless the prior art suggested the desirability of the modification. See: In re Gordon, 221 USPQ 1125 (CAFC 1984); In re Grabiak, 226 USPQ 870 (CAFC 1985); and In re Sernaker, 217 USPQ 1 (CAFC 1983).

On page 10 of the final rejection, the Examiner simply states that Applicant's arguments are "not persuasive". The Examiner's statement that Setzer et al's disclosure of "amounts below those amounts detectable and encompass applicants' 0.05 ppm." doesn't make grammatical sense for one thing, and, that said, it is crystal clear that the Setzer et al sulfur detector **cannot detect** amounts of sulfur that are between 0.05 ppm and 20 ppm, and therefore **it would be unable to perform** the method defined by Claims 1-8. Setzer et al does not supply any suggestions as to how one could make the sulfur detector more sensitive so as to be able to detect levels of sulfur in the desulfurizer effluent which are lower than 20 ppm.

The last full paragraph on page 10 of the final rejection is essentially a denial of the fact that the Examiner bears the burden of proof on this question. Note the statement: "it is not necessary that the examiner set forth specific modifications to achieve such amounts.". This is clearly erroneous. The Examiner must, under the case law, point to some modification of the reference(s) she is relying on that would render the claimed subject matter in question obvious. The penultimate sentence in the last full paragraph on page 10 of the final rejection is clearly erroneous. It is crystal clear that the process of Setzer et al will produce a level of desulfurization that results in amounts of sulfur in the effluent which are between 0.05 and 20 ppm which are clearly different from that claimed by applicants. With all due respect, one thing that the Examiner does not seem to realize here is that this rejection is based **solely** on the disclosure of the Setzer et al reference, **and on nothing else**. There is absolutely no suggestion in Setzer et al that levels of sulfur in the desulfurizer effluent

which are greater than 0.05 ppm **cannot** be tolerated. In fact the reference expressly indicates that they **can** be tolerated.

Thus the §103 rejection of Claims 1-8 which is based **solely on** Setzer et al is clearly erroneous, and the Honorable Board is respectfully requested to reverse this rejection.

Claims 20 and 21

Claims 20 and 21 require that the nickel reactant desulfurizer station operate at a temperature in the range of about 300°F to about 450°F. These claims also require that hydrogen and water which are mixed with the liquid gasoline fuel being desulfurized be obtained from a fuel cell selective oxidizer output recycle. These claims have also been rejected **solely** on the teachings of Setzer et al. Regarding these two additional limitations, the Examiner admits that the Setzer et al reference does not disclose operating the desulfurization station at a temperature in the range of about 300°F and about 450°F; and that the reference "is silent" about the recirculating of water.

In addressing the operating temperature range requirement of Claims 20 and 21, the Examiner states that: "It would have been obvious to one of ordinary skill in the art at the time the invention was made to accomplish the desulfurization of Setzer et al at a temperature of 450°F because the prior art range **is close enough** that one skilled in the art would have expected it to have the same conversion properties including sulfur removal ability." (emphasis added) (see page 4, second full paragraph of the final rejection).

In support of her position, the Examiner states that the 500°F to 900°F operating temperature range specified in Setzer et al '746 is "only a preferred embodiment", citing Col.1, lines 67 and 68 of the patent. As a matter of fact, the 500°F to 900°F operating range is the only operating range disclosed in Setzer et al '746. The Examiner characterizes the temperature range disclosure of Setzer et al '746 as a "broad" disclosure which merely requires an "elevated" temperature. With all due respect, if Applicants in this application were claiming merely "an elevated temperature", the Examiner would rightfully require a specific range, and would object to the vague recitation of "an elevated temperature".

In Setzer et al '746 "breakthrough" is a condition which is not desirable. It, in fact, denotes failure of the sulfur removal bed, as far as Setzer et al '746 is concerned. It is thus elementary that postponement of breakthrough is most desirable. FIG. 2 in Setzer et al '746 provides clues as to the relationship between the time to reach breakthrough (in hours) and the operating temperature (in degrees F) of the desulfurizing bed. FIG. 2 indicates that breakthrough will occur after about 9 hours from start up at an operating temperature of

500°F, and the longest breakthrough time (about 16 hours) will occur at an operating temperature of about 600°F. FIG. 2 also indicates that the breakthrough time decays at temperatures between 600°F and 900°F. FIG. 2 indicates that breakthrough times at 900°F and 500°F are about the same, i.e., about 9 to 10 hours.

The Examiner has necessarily alleged that the upper end of the claimed temperature range (450°F) is close enough to the lower end of the prior art temperature range (500°F) so that one of ordinary skill in the art would be motivated by the prior art, or would believe that the claimed 450°F temperature would be desirable to use in the performance of the prior art Setzer et al procedure. We interpret the Examiner's position as alleging that the use of a 450°F operating temperature in the Setzer et al '745 procedure would be desirable and should be used. Looking at FIG. 2 of Setzer et al '745 we note that the graph indicates that there is a linear decrement in the breakthrough time between the operating temperatures of 600°F and 900°F, and that the use of temperatures which are greater than 600°F are more desirable than the temperature of 500°F. Operating temperatures below 500°F, if extrapolated from FIG. 2, would provide a breakthrough time which appears to decline logarithmically, and which appears to be at zero hours before reaching an operating temperature of 450°F. Thus the only correlation between operating temperatures and the achievement of breakthrough shown in Setzer et al '745 is shown in FIG. 2 and indicates that it would not be desirable to utilize an operating temperature which is below 500°F.

Setzer et al '745 thus **does not** suggest that an operating temperature of less than 500°F would be desirable, or even operable. The teachings of Setzer et al '745 would not "motivate" one skilled in the art to utilize an operating temperature which is included in the range of temperatures that are recited in Claims 20 and 21 of the instant application, irregardless of how "close" the upper end of the range of the claimed operating temperatures is to the lower end of the range of operating temperatures set forth in Setzer et al. The Examiner's allegation that the lowest operating temperature suggested by Setzer et al is close enough to the highest operating temperature set forth in Claims 20 and 21 so as to suggest to one skilled in the art that the 450°F operating temperature of the claims would suffice for the Setzer et al system is clearly erroneous.

Regarding the use of selective oxidizer output recycle admixed with a liquid gasoline being desulfurized, the Examiner merely states that the Setzer et al reference "is silent" about the recirculating of water. The reference is not "silent" regarding this limitation, in fact, the reference simply does not suggest the desirability of using a selective oxidizer output

recycle in its desulfurizing procedure or system. The Examiner states on page 4, last full paragraph of the final rejection, that: "it would have been obvious to one of skill in the art at the time the invention was made to utilize water obtained from any source +++ including recycle from a selective oxidizer output, because the water composition is the same regardless of the source. This latter statement by the Examiner is clearly erroneous, as proven by the claims in question. The Honorable board's attention is directed to clause c) of Claims 20 and 21 wherein the composition of selective oxidizer output recycle is defined. It is not just water, as the Examiner seems to think, it is a combination of water and hydrogen. Setzer et al suggests that the addition of hydrogen to the water-fuel mixture is desirable (see the last paragraph in Col. 1 of Setzer et al). FIG. 1 of Setzer et al illustrates how the reference creates the fuel-steam-hydrogen mixture. The fuel comes from one source and is pumped into a boiler; the water comes from a second source and is pumped into the boiler; and the hydrogen comes from a third source (see hydrogen supply) and is mixed with the vaporized fuel-steam mixture prior to entering the desulfurizer bed. Setzer et al provides absolutely no motivation or suggestion that a selective oxidizer effluent could be used as a source of both water and hydrogen for the desulfurizing process. The claimed method thus uses a by-product of the fuel cell power plant process to enhance the desulfurizing step without further complicating the fuel cell power plant assemblage. The use of a fuel cell power plant by-product in connection with the desulfurizing of the fuel is not suggested anywhere in Setzer et al. We do not agree with the Examiner's broad allegations which she uses when the cited prior art admittedly does not suggest the desirability of certain claim limitations, that, characterizations such as "any degree required"; "close enough"; "from any source"; "any feed"; or the like generalizations are sufficient to satisfy the Examiner's initial burden of proof in putting forth an argument for obviousness (see page 4 of the final rejection for these specific generalizations).

Claims 22-25

All of these claims require the use of selective oxidizer recycle as an additive to the fuel stream which is being desulfurized. The selective oxidizer recycle must include both water and hydrogen. The selective oxidizer recycle must also be present in the fuel stream in an amount that will provide an effluent gaseous fuel stream at an exit end of the nickel reactant station which contains no more than about 0.05 ppm by weight sulfur. As noted above, Setzer et al does not suggest the use of a fuel cell power plant selective oxidizer recycle as an additive to a fuel stream and does not suggest that the recycle be present in an amount that will provide an effluent gaseous fuel stream from the desulfurizing station that contains no more than about 0.05 ppm by weight sulfur. As noted above, these limitations are not suggested by the Setzer et al reference considered by itself.

Claim 23 adds the limitation that the fuel stock is a fuel selected from a plurality of specific

fuels. Setzer et al does not suggest any of the fuels recited in Claim 23, and, in fact, Setzer et al relates solely to the desulfurization of JP-4 jet fuel.

Claim 24 adds a desulfurizing station operating temperature range of about 250°F to about 450°F. As discussed above in excruciating detail, Setzer et al does not suggest that this temperature range would be useful, and, indeed, suggests that this temperature would be inoperable.

Claim 25 recites a specific range of percentages of the recirculated portion of the selective oxidizer output which is used as a source of water and hydrogen in the method. In the final rejection, the Examiner **has completely ignored** the method limitations put forth in Claim 25. It is error to ignore specific claim limitations distinguishing over the disclosures of the references relied upon by an examiner in rejecting claims. See: In re Glass, 176 USPQ 489 (CCPA 1973); and In re Chandler, 117 USPQ 361 (CCPA 1958). Moreover, Setzer et al, obviously, is completely devoid of any teachings which suggest the desirability of the claimed percentage range. The Examiner's treatment, or lack thereof, of the subject matter of this claim **is clearly erroneous**.

The rejections of Claims 22-25 which are based solely on Setzer et al are clearly erroneous and should be reversed.

Claim 9:

Claim 9 has been rejected as being obvious over the combined teachings of Setzer et al and Alexander et al. The flaws in the Examiner's analysis of Setzer et al '746 relating to the sulfur content of the desulfurizing bed effluent are noted above, and are reiterated in connection with this rejection.

Alexander et al is relied upon by the Examiner for a showing that "conventional gasoline marketed in large metropolitan areas contains oxygenates including methanol, ethanol and MTBE. See column 1, lines 1-25.". What the Examiner is ignoring is the contents of the third full paragraph in Col. 1 (lines 26-33) of Alexander et al wherein the patent notes that there are many problems associated with the use of methanol and ethanol as a gasoline additive, and therefore the industry would not suggest the use of either of these two additives in gasoline. This patent thus teaches away from the use of an organic additive in gasoline. Additionally, the use of MTBE as a gasoline additive has recently come under attack since there is evidence that MTBE is a cancer-causing agent. MTBE in gasoline has or will be banned in California, and will be banned in Connecticut and elsewhere, in the near future. We are sure that the Examiner must also be aware that there are gasolines that do

not include MTBE, or any other organic oxygenates, presently in use in the United States. Thus, there are presently gasolines which do include MTBE, and gasolines which do not include MTBE or any other oxygenates. This being the case, the Examiner has the burden of proof in showing that one desiring to desulfurize a gasoline or diesel fuel stock would be motivated to use a fuel stock which includes an oxygenate. One point that the Examiner seems to be missing regarding the subject matter of Claim 9 is that the oxygenates present in the fuel stock are converted to other compounds during the desulfurization process. This chemical reaction does not occur when a gasoline with an MTBE oxygenate is simply burned in an internal combustion engine. Thus, Alexander et al warns against using gasoline have an MTBE oxygenate additive.

On page 11 of the final rejection, the Examiner argues that Applicants are relying on different portions of Alexander et al than the Examiner is relying on. With all due respect, the Applicants are merely relying on the entirety of the Alexander et al reference. It is the Examiner that is relying on only parts of the reference. The Examiner states that: "One of ordinary skill in the art would be motivated to add applicants' claimed oxygenates to the fuel of Setzer et al because such oxygenates are known to improve fuel octane as evidenced by the secondary reference." (pages 11-12, final rejection). This argument ignores the fact that in California, at least, it will shortly be illegal to sell gasoline containing MTBE because it is a cancer causing agent when used to fuel automobiles. According to the Examiner's argument, one of ordinary skill in the art would be motivated to do something that will be illegal, at least in California, in order to improve fuel octane. Enclosed is a copy of an article from the internet which reports California's impending ban on the use of MTBE in gasoline.

It is respectfully submitted that the Examiner's rejection of Claim 9 as being obvious in view of the combined teachings of Setzer et al and Alexander et al is clearly erroneous since Alexander et al discourages the use of organic oxygenates such as MTBE in gasoline to improve octane ratings, and since MTBE has been shown to be a cancer-causing agent when added to gasoline, and will soon be banned in one or more states in the USA. As noted above, the subject matter of Claim 9 eliminates the MTBE in gasoline during the desulfurizing process by converting it to another compound. Nothing in the cited prior art suggests that this result will occur. The Honorable Board is thus respectfully requested to reverse the final rejection of Claim 9.

Claim 10:

Claim 10 has been rejected as being obvious over the combined teachings of Setzer et al and Alexander et al. The flaws in the Examiner's analysis of Setzer et al '746 relating to the sulfur content of the desulfurizing bed effluent are noted above, and are reiterated in connection with this rejection. Claim 10 also requires the chemical conversion of the

oxygenate to another compound, and further specifies that the low sulfur gas stream must continue to be formed so long as the nickel reactant continues to convert the oxygenate to another compound. Neither of the cited and applied references suggest the desirability of any of these claim limitations. The final rejection of Claim 10 should therefore be reversed.

Claim 11:

Claim 11 has been rejected as being obvious over the combined teachings of Setzer et al and Alexander et al. The flaws in the Examiner's analysis of Setzer et al '746 relating to the sulfur content of the desulfurizing bed effluent are noted above, and are reiterated in connection with this rejection. The flaws in the Examiner's analysis of Setzer et al '746 relating to the operating temperatures of the desulfurizing bed are noted above, and are reiterated in connection with this rejection. The conversion of the oxygenate to other specified compounds is also recited in Claim 11. This limitation is not suggested by the cited prior art. This chemical conversion removes otherwise harmful compounds, such as MTBE from the fuel stream before the fuel stream is combusted. Claim 11 also includes the requirement that the low sulfur gas stream must continue to be formed so long as the nickel reactant continues to convert the oxygenate to another compound. This requirement is not suggested by either of the references cited and relied on by the Examiner in the final rejection. The final rejection of Claim 11 should therefore be reversed.

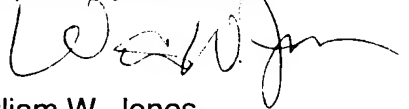
The unexpected results arguments put forth by the Examiner:

In the final rejection, the Examiner has repeatedly referred to a requirement that Applicants must show "unexpected" results which are derived from the claim limitations that the Examiner admits that she cannot find in the applied references (see page 4, second full paragraph; page 5, line 3; page 7, last full paragraph; and page 11, first full paragraph of the final rejection). These arguments or requirements put forth by the Examiner in the final rejection are non-statutory. There is no requirement for anything "unexpected" in Title 35 of the patent statute. Kansas Jack, Inc. v Kuhn et al 219 USPQ 857 (CAFC 1983). A §103 rejection requires that the modification be obvious in view of the prior art. A modification is "obvious" if the prior art provides some motivation to incorporate the modification, or some indication that the modification would be desirable. The Examiner has the burden of proof to point out where that motivation or desirability is provided in the prior art. In Ex parte Levy, 17 USPQ2d 1461 (US PTO Bd. Pat. App. & Int. 1990), the Board held that the initial burden of establishing a *prima facie* basis to deny patentability rests upon the examiner. See also In re Carleton, 202 USPQ 165 (CCPA 1979); and In re Piasecki, 223 USPQ 785 (Fed. Cir. 1984). This burden can only be discharged by establishing a factual basis for the finding of non-patentability.

SUMMARY

The Honorable Board is respectfully requested to reverse the rejections of Claims 1-8, 9,10, 11, 20-21, and 22-25 in this application.

Respectfully submitted,



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Date: 9-13-23

(9) APPENDIX:

1.(original) A method for desulfurizing a hydrocarbon fuel stream so as to convert the hydrocarbon fuel stream into a low sulfur content fuel, which low sulfur content fuel is suitable for use in a fuel processing section in a fuel cell power plant, said method comprising the steps of:

- a) providing a nickel reactant desulfurization station which is operative to convert sulfur contained in organic sulfur compounds contained in the fuel stream to nickel sulfide;
- b) introducing a hydrocarbon fuel stream which contains an oxygenate into said nickel reactant desulfurization station; and
- c) said oxygenate being present in said fuel stream in an amount which is effective to provide an effluent fuel stream at an exit end of said nickel reactant station which effluent fuel stream contains no more than about 0.05 ppm sulfur by weight.

2.(original) The method of Claim 1 wherein the oxygenate is selected from the group consisting of water, alcohol, ether, and mixtures thereof.

3.(previously amended) The method of Claim 2 wherein said oxygenate is present in amounts operable to provide an operating life for the method which is at least about three times the operating life of a desulfurizing method which does not include an oxygenate in the fuel stream.

4.(original) The method of Claim 2 wherein the oxygenate is selected from the group consisting of water, MTBE, ethanol, methanol, and mixtures thereof.

5.(original) A method for desulfurizing a gasoline fuel stream so as to convert the gasoline fuel stream into a low sulfur content fuel, which low sulfur content fuel is suitable for use in a fuel processing section in a fuel cell power plant, said method comprising the steps of:

- a) providing a nickel reactant desulfurization station which is operative to convert sulfur contained in organic sulfur compounds contained in the fuel stream to nickel sulfide;
- b) introducing a gasoline fuel stream which contains an oxygenate into said nickel reactant desulfurization station; and
- c) said oxygenate being present in said gasoline fuel stream in an amount which is effective to provide an effluent gasoline fuel stream at an exit end of said nickel reactant station which effluent gasoline fuel stream contains no more than about 0.05 ppm sulfur by weight.

6.(original) The method of Claim 5 wherein the oxygenate is selected from the group consisting of water, alcohol, ether, and mixtures thereof.

7.(original) The method of Claim 6 wherein the oxygenate is selected from the group

consisting of water, MTBE, ethanol, methanol, and mixtures thereof.

8.(original) A method for desulfurizing a gasoline fuel stream so as to convert the gasoline fuel stream into a low sulfur content fuel, which low sulfur content fuel is suitable for use in a fuel processing section of a fuel cell power plant, said method comprising the steps of:

- a) providing a nickel reactant desulfurization station which is operative to convert sulfur contained in organic sulfur compounds contained in the fuel stream to nickel sulfide;
- b) introducing a gasoline fuel stream which contains an oxygenate into said nickel reactant desulfurization station; and
- c) said oxygenate being present in said gasoline fuel stream in an amount which is effective to provide a continuous gasoline fuel stream at an exit end of said nickel reactant station which continuous gasoline fuel stream contains on average no more than about 0.05 ppm sulfur.

9.(original) A method for desulfurizing a gasoline fuel stream so as to convert the gasoline fuel stream into a low sulfur content fuel, which low sulfur content fuel is suitable for use in a fuel processing section in a fuel cell power plant, said method comprising the steps of:

- a) providing a nickel reactant desulfurization station which is operative to convert sulfur contained in organic sulfur compounds contained in the fuel stream to nickel sulfide;
- b) introducing a gasoline fuel stream which contains an oxygenate into said nickel reactant desulfurization station; and
- c) said oxygenate being converted to isobutylene and methanol by said nickel catalyst in amounts which are effective to inhibit carbon deposition in said nickel catalyst station and provide a continuous gasoline fuel stream at an exit end of said nickel reactant station which continuous gasoline fuel stream contains no more than about 0.05 ppm sulfur by weight.

10.(original) A method for desulfurizing a gasoline fuel stream so as to convert the gasoline fuel stream into a low sulfur content fuel, which low sulfur content fuel is suitable for use in a fuel processing section in a fuel cell power plant, said method comprising the steps of:

- a) providing a nickel reactant desulfurization station which is operative to convert sulfur contained in organic sulfur compounds contained in the fuel stream to nickel sulfide;
- b) introducing a gasoline fuel stream which contains an oxygenate into said nickel reactant desulfurization station, said oxygenate being present in said gasoline fuel stream in an amount which is effective to provide a low sulfur content gasoline fuel stream at an exit end of said nickel catalyst station which low sulfur content gasoline fuel stream contains no more than about 0.05 ppm by weight sulfur; and
- c) said oxygenate being converted to isobutylene and methanol by said nickel reactant during said desulfurizing step, said low sulfur content gasoline fuel stream being formed so long as said nickel reactant continues to convert the oxygenate.

11.(original) A method for desulfurizing a liquid gasoline fuel stream so as to convert the gasoline fuel stream into a low sulfur content fuel, which low sulfur content fuel is suitable for use in a fuel processing section in a fuel cell power plant, said method comprising the steps of:

- a) providing a nickel reactant desulfurization station which is operative to convert sulfur contained in organic sulfur compounds contained in the fuel stream to nickel sulfide;
- b) maintaining said nickel reactant desulfurization station at a temperature in the range of about 300°F to about 450°F;
- c) introducing a liquid gasoline fuel stream which contains an oxygenate into said nickel reactant desulfurization station, said oxygenate being present in said gasoline fuel stream in an amount which is effective to provide a low sulfur content gasoline fuel stream at an exit end of said nickel reactant station which low sulfur content gasoline fuel stream contains no more than about 0.05 ppm sulfur; and
- d) said oxygenate being converted to isobutylene and methanol by said nickel reactant during said desulfurizing step, said low sulfur content gasoline fuel stream being formed so long as said nickel reactant continues to convert the oxygenate.

~~12.(previously canceled) A method for desulfurizing a liquid gasoline fuel stream so as to convert the gasoline fuel stream into a low sulfur content fuel, which low sulfur content fuel is suitable for use in a fuel processing section in a fuel cell power plant, said method comprising the steps of:~~

- ~~a) providing a nickel reactant desulfurization station which is operative to convert sulfur contained in organic sulfur compounds contained in the fuel stream to nickel sulfide;~~
- ~~b) maintaining said nickel reactant desulfurization station at a temperature in the range of about 300°F to about 450°F;~~
- ~~c) introducing a mixture of about 2% to about 5% water and a liquid gasoline fuel stream, which mixture contains an oxygenate, into said nickel reactant desulfurization station, said oxygenate being present in said mixture in an amount which is effective to provide a low sulfur content gasoline fuel stream at an exit end of said nickel reactant station, which low sulfur content gasoline fuel stream contains no more than about 0.05 ppm sulfur; and~~
- ~~d) said oxygenate being consumed by said nickel reactant during said desulfurizing step, said low sulfur content gasoline fuel stream being formed so long as said nickel reactant continues to consume the oxygenate.~~

~~13.(previously canceled) The method of Claim 12 wherein the water in said mixture is derived by recirculating a portion of a selective oxidizer output back to an inlet to said nickel reactant station.~~

14.(previously canceled) ~~The method of Claim 12 wherein the water in said mixture is the sole oxygenate in said mixture.~~

15.(previously canceled) ~~The method of Claim 12 wherein the oxygenate includes an alcohol present in said gasoline fuel stream.~~

16.(previously canceled) ~~The method of Claim 14 wherein the alcohol is selected from the group consisting of methanol, ethanol, propanol, and mixtures thereof.~~

17.(previously canceled) ~~The method of Claim 12 wherein said oxygenate is an ether.~~

18.(previously canceled) ~~The method of Claim 16 wherein said oxygenate is MTBE.~~

19.(previously canceled) ~~The method of Claim 12 wherein said recirculated portion of the selective oxidizer output is between 1% and 10% of the total selective oxidizer output.~~

20.(original) A method for desulfurizing a liquid gasoline fuel stream so as to convert the gasoline fuel stream into a low sulfur content fuel, which low sulfur content fuel is suitable for use in a fuel processing section in a fuel cell power plant, said method comprising the steps of:

- a) providing a nickel reactant desulfurization station which is operative to convert sulfur contained in organic sulfur compounds contained in the fuel stream to nickel sulfide;
- b) maintaining said nickel reactant desulfurization station at a temperature in the range of about 300°F to about 450°F; and
- c) introducing a mixture of a fuel cell selective oxidizer output recycle, which recycle contains hydrogen and water; and a liquid gasoline fuel, into said nickel reactant desulfurization station, said selective oxidizer output recycle being present in an amount which is effective to provide a low sulfur content gasoline fuel stream at an exit end of said nickel reactant station, which low sulfur content gasoline fuel stream contains no more than about 0.05 ppm by weight sulfur.

21.(original) The method of Claim 20 wherein said selective oxidizer recycle comprises about 1% to about 10% of total selective oxidizer output.

22.(original) A method for desulfurizing a gaseous fuel stream so as to convert the gaseous fuel stream into a low sulfur content fuel, which low sulfur content fuel is suitable for use in a fuel processing section in a fuel cell power plant, said method comprising the steps of:

- a) providing a nickel reactant desulfurization station which is operative to convert sulfur contained in organic sulfur compounds contained in the fuel stream to nickel sulfide;

b) introducing a gaseous fuel stream which contains a fuel cell selective oxidizer recycle mixture of hydrogen and water into said nickel reactant desulfurization station; and
c) said selective oxidizer recycle mixture being present in said gaseous fuel stream in an amount which is effective to provide an effluent gaseous fuel stream at an exit end of said nickel reactant station which effluent gaseous fuel stream contains no more than about 0.05 ppm by weight sulfur.

23.(original) The method of Claim 22 wherein the gaseous fuel is selected from the group consisting of methane, ethane, propane and butane.

24.(original) The method of Claim 22 wherein the desulfurization station operates in a temperature range of about 250°F to about 450°F.

25.(original) The method of Claim 22 wherein said recirculated portion of the selective oxidizer output is between 1% and 10% of the total selective oxidizer output.

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Energy Commission MTBE Study

Study of Alternatives to Methyl Tertiary-Butyl Ether, An Oxygenate in California Reformulated Gasoline

On March 25, 1999, Governor Gray Davis released Executive Order 1 that ordered the removal of the additive MTBE (Methyl Tertiary-Butyl Ether) from California gasoline at the earliest possible date, but no later than December 31, 2002.

On March 15, 2002, the Governor issued a new Executive Order and announced a one-year extension to the phase out of MTBE. "Under the announced timeline, the MTBE phaseout will be accomplished no later than December 31, 2003. Individual refineries have may continue to make the transition to ethanol earlier than December 2003 if they determine it is feasible and will not risk supply shortages or price spikes."

In the original 1999 Executive Order, the Governor directed the California Energy Commission to evaluate and report to the Governor and the Department of Environmental Protection on the potential for development of a cellulosic waste-based or other biomass ethanol industry. The Commission was directed to "...evaluate what steps, if any, would be appropriate to foster the development of a waste-based or other biomass ethanol development in California should ethanol be found to be an acceptable substitute for MTBE."

For more information regarding the Energy Commission MTBE Study, please contact:

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